

Isao YOSHIMURA\* and David L. HAWKSWORTH\*\*: **The typification and chemical substances of *Lobaria pulmonaria* (L.) Hoffm.**

吉村 庸\*・D. L. ハウクスウォース\*\*: カブトゴケの  
基準標本の選定と化学成分

(Plates I—II)

*Lobaria pulmonaria* (L.) Hoffm. is a conspicuous reticulately costate foliose lichen known from the sixteenth century as 'lung-wort' or 'lung-lichen'. Although very many infraspecific taxa have been described from Europe, Asia, North America, Australia and Africa, its basionym, *Lichen pulmonarius* L. has never been properly typified, and so the application of some of these names has led to nomenclatural confusions.

Some chemical races of lung-lichens which have generally been considered as *Lobaria pulmonaria* have previously been described (e.g. Hale, 1967; Culberson, 1969) and so it was also necessary to ascertain to which chemical race the type belonged. It is the purpose of the present paper to discuss the typification, nomenclature and chemistry of *Lobaria pulmonaria* and its allies.

We are very grateful to Dr. W. T. Stearn for permission to examine specimens from the herbarium of the Linnean Society of London (LINN) without which the typification of *Lichen pulmonarius* L. would have been impossible; to Dr. A. R. Perry, Oxford University (OXF), Dr. I. M. Lamb, Farlow Herbarium, Harvard University (FH), Dr. T. Ahti and Dr. P. Isoviita, Helsinki University (H), Dr. T. Alava, Turku University (TUR), Dr. M. E. Hale, U.S. National Museum (US), and Dr. S. Kurokawa, National Science Museum, Tokyo (TNS), for the loan of specimens in their herbaria; to Mr. J. R. Laundon for his criticism of our original manuscript; and to Dr. S. Huneck for purified samples of some lichen substances. In addition, the senior author would also like to thank Drs. Y. Asahina, S. Hattori and A. J.

\* The Hattori Botanical Laboratory, Obi, Nichinan, Miyazaki Pref., Japan. 服部植物研究所

\*\* Commonwealth Mycological Institute, Ferry Lane, Kew, Richmond, Surrey, England.

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**Typification** *Lichen pulmonarius* L. was based by Linnaeus (1753, p. 1145–1146) on five pre-1753 taxa:—*Lichenoides pulmoneum reticulatum vulgare* Dillenius (1741, tab. 113), *Pulmonaria* Fuchs (1542, p. 636–638), *Muscus pulmonarius* Bauhin (1671, p. 361), *Lichen foliis oblongis divis, superficie reticulata & punctata* Linnaeus (1737, p. 339), and *Lichen foliaceus repens laciniatus obtusus glaber: supra lacunosus subtus tomentosus* Linnaeus (1745, p. 350). It is also of interest to record here that figures which clearly belong to this species were published by Dodoens (1583, p. 471) and Micheli (1729, tab. 45).

Although most of these pre-Linnean names may be lectotyped by illustrations as the specimens on which they were based appear to have been lost, specimens of both Dillenius and Linnaeus are still extant in the herbaria of Oxford University (OXF, Plate II a) and the Linnean Society of London (LINN), respectively. As adequate material of *Lichen pulmonarius* L. is present in C. Linnaeus' herbarium, it is unnecessary to select one of the pre-Linnean figures or specimens cited by Linnaeus (1753) as a lectotype. As a general rule it would appear to be desirable only to use Dillenian or other non-Linnean specimens or illustrations as lectotypes for Linnean taxa when no authentic material is present in LINN (e.g. *Lichen geographicus*

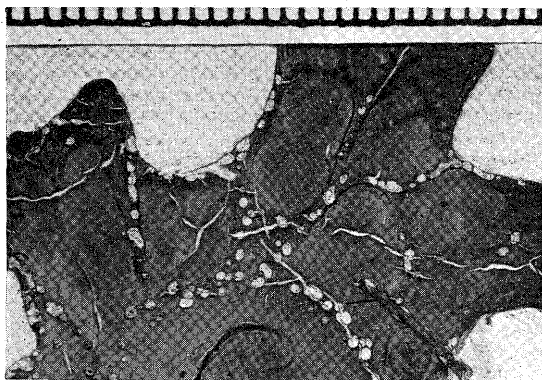


Fig. 1. A portion of the thallus with soralia of *Lichen pulmonarius* L., Herb. C. Linnaeus, sheet no. 1273.103 (upper specimen), LINN. Scale in mm.

*L.* discussed by Hawksworth and Sowter, 1969) particularly as, for example, the Dillenian specimens are not always the same species as the Linnean ones (e.g. *Lichen jubatus* L. discussed by Hawksworth, 1970).

*Lichen pulmonarius* L. is represented by four sheets in C. Linnaeus' herbarium (LINN sheets

no. 1273.103—106) all of which, as reported by Vainio (1886, p. 5), belong to *Lobaria pulmonaria* as understood by post-Linnean authors. The documentation and morphological characters of these are as follows:—

1273.103: This sheet bears (a) both the *Species Plantarum* and *Flora Suecica* numbers in C. Linnaeus' handwriting, (b) the name 'pulmonarius' in Linn. fil. handwriting, and (c) '*Lichenoides* 113. Dill.' on the back of the sheet in (?) C. Linnaeus' handwriting. Both the upper and lower specimens on the sheet appeared to be identical in morphological characters. Apothecia and pycnidia are absent; soralia are present, restricted to the ridges of the reticulations, plane to slightly convex, not tuberculate, to 1.0 mm in diameter; isidia were not noted even in the soralia (Fig. 1).

1273.104: This sheet bears both the *Species Plantarum* and *Flora Suecica* numbers, and the name 'pulmonarius' but these do not appear to be either in C. Linnaeus' or Linn. fil. handwriting. Apothecia frequent on the margins, to 2.0 mm in diameter, excipulum thallinum strongly inflexed and concolourous with the disc which is reddish, matt, and concave; pycnidia are abundant near the apices, on both the lamina and reticulations, to 0.3 mm in diameter, black and shining; soralia rather sparse, largely confined to the margins, plane to slightly convex, to 0.8 mm in diameter; isidia sparse, largely confined to the margins but also arising in the soralia, to 0.3 mm in height.

1273.105: This sheet has the *Species Plantarum* and *Flora Suecica* numbers and '09' (probably '60' inverted) but no name. It is not clear whose handwriting these are in. Apothecia absent; a few pycnidia near the apices of some lobes superficially identical to those in 1273.104; soralia abundant, confined to the margins and ridges of the reticulations, to 1.5 mm in diameter or coalescing so that the whole ridge appears as one mass of soredia in parts; isidia present, poorly developed, largely restricted to the soralia, forming a non-sorediate crust on some margins, to 0.2 mm in height.

1273.106: This sheet bears only the name 'pulmonarius' in Linn. fil. handwriting. Apothecia and pycnidia absent; soralia and isidia identical to those in 1273.105 except that the isidia appear to be restricted to the soralia.

In view of the writing on the sheets it is clear that sheet 1273.103 has most claim to be regarded as the type since it fulfills all the criteria of authenticity for these specimens enumerated by Howe (1912). As both

the upper and lower specimens on this sheet (Plate I) are identical except in size, and the lower one is the larger, we designate the lower specimen on LINN sheet no. 1273.103 as the lectotype of *Lichen pulmonarius* L.

**Chemistry** With the permission of the Curator of the Linnean Herbarium (Dr. W. T. Stearn) and the kind co-operation of Mr. J. R. Laundon, the junior author removed fragments from each on the Linnean sheets mentioned above. One half of each fragment was examined independently by each of us with the following results:—

Thallus and medulla reactions (D. L. H.<sup>1)</sup> and I. Y.<sup>2)</sup>): The medulla of all five specimens gave the reactions  $K^{3)} +$  yellow to deep yellow or orange,  $KC-$ ,  $C-$  and  $P+$  orange.

Microcrystal tests (D. L. H. and I. Y.): The acetone extracts of all five specimens gave crystals of stictic acid in oT and of norstictic acid in KK. The tests for norstictic acid in KK on the extracts from specimens 1273.104 and 1273.106 were found by us both to fail the first time we tried them although the KK solution was coloured reddish-orange.

Chromatography (I. Y.): The acetonic residues were spotted onto Merck precoated silica-gel glass plates 10 cm long, and developed for about 15 min. in a solvent of 5 parts *n*-hexane, 4 parts ethyl acetate, and 0.7 parts formic acid. The plates were then sprayed with 10% sulphuric acid and heated in an electric oven at about 70°C for about 10 min. when the spots became visible. Pure samples of stictic, norstictic, and gyrophoric acids and tenuinorin were also spotted on the plates. An acetone extract of *Lobaria oregana* (Tuck.) Müll. Arg. was used as a comparison source of constictic acid as this species was mentioned in the original description of this acid by Asahina (1968). Constictic acid gave an orange-red spot at  $R_f$  0.08; stictic acid

<sup>1)</sup> Abbreviation for the junior author, D. L. Hawksworth.

<sup>2)</sup> Abbreviation for the senior author, I. Yoshimura.

<sup>3)</sup> The following abbreviations are used for reagents in this paper:  $K=10\%$  aqueous solution of potassium hydroxide.  $C=freshly$  prepared bleaching powder solution (I. Y.) or commercial 'Parazone' produced by Jeyes Ltd. (D. L. H.).  $KC=K$  applied first and quickly followed by  $C$ .  $P=freshly$  prepared 2% alcoholic solution of *p*-phenylenediamine (I. Y.) or Steiners' Stable P-solution (D. L. H.).  $KK=complex$  potassium hydroxide solution composed of equal parts of 5% KOH and 20%  $K_2CO_3$ .  $oT=2$  parts glycerol, 1 part ethanol, 1 part *o*-toluidene.

an orange-red spot at Rf 0.30; norstictic acid a yellow spot at Rf 0.50; gyrophoric acid an orange-yellow spot at Rf 0.46; and tenuiorin an orange-yellow spot at Rf 0.67.

All five Linnean specimens were found to contain stictic, constictic, and norstictic acids.

**Chemical Variation** Fifty-eight sorediate specimens from TNS, NICH and Herb. D.L. Hawksworth, were tested by thin-layer chromatography as described above. Of these only one, from Newfoundland, contained norstictic acid alone (Chemical race II), the other fifty-seven containing norstictic, constictic and stictic acids (Chemical race I). None of the above sorediate specimens contained either gyrophoric, or usnic acids or tenuiorin or thelephoric acid.

These results are in agreement with the data of Culberson (1969) who reported only two specimens of chemical race II—both from eastern North America (Virginia and New Brunswick), and also pointed out earlier records of norstictic acid containing specimens from Europe.

Schindler (1936) tested 124 specimens of *Lobaria pulmonaria* (probably including non-sorediate forms) and found that 40% of these produced reddish crystals of norstictic acid in caustic potash (KOH) solution. These results must at least in part be due to the difficulty of demonstrating this acid by microcrystal tests. Hale (1967), however, distinguished three chemical races based on microcrystal tests with: (i) stictic acid alone, (ii) norstictic acid alone, and (iii) stictic and norstictic acids. In the course of our studies we have not found any stictic acid alone plants which may be either because we have examined too few specimens or because the techniques used by Hale were insensitive to low concentrations of norstictic acid in the presence of stictic acid. As pointed out by Culberson (1967), stictic acid could theoretically be derived from norstictic acid by a one step methylation, and so norstictic acid could be visualised as a possible precursor of stictic acid. The relationships between these two acids in the *Lobaria pulmonaria* complex may be similar to that proposed by Culberson (1967) for them in the *Ramalina siliquosa* complex.

#### Nomenclature

***Lobaria pulmonaria*** (L.) Hoffm., Deutschl. Flora 2: 146 (1796).

*Lichen pulmonarius* L., Sp. Plant. 2: 1145 (1753). Lectotype:—*sine loc.*,

Herb. C. Linnaeus, sheet 1273.103 (lower specimen), LINN! (Plate I). *Parmelia pulmonaria* (L.) Sprengl., Fl. Halens.: 335 (1806). *Platysma pulmonarius* (L.) Frage, Deutschl. Bot. Taschenb. 2: 165 (1812). *Sticta pulmonaria* (L.) Birola, Fl. Asconiens. 2: 188 (1808). *Parmelia pulmonacea* Ach., Meth. Lich.: 220 (1803). *Lobaria pulmonacea* (Ach.) Shirley, Trans. R. Soc. Queensl. 6: 27 (1889).

*Lobaria africana* Dodge, Nova Hedwigia beih. 12: 150 (1964). Holotype:—Africa—Cape of Good Hope, Grootvaderbosch, on decayed wood, Zeyher, Herb. T. Taylor, FH! (Plate IIb).

Chemical race I:—contains stictic, constictic, and norstictic acids.

Chemical race II:—contains norstictic acid only.

Distribution:—Chemical race I, to which the lectotype of *Lichen pulmonarius* L. and the holotype of *Lobaria africana* Dodge belong, is circumpolar in the Northern Hemisphere, being reported from Alaska, Canada, south to the Appalachians and Mexico in North America; Europe; and Sakhalin and North Korea in Asia (Fig. 2). It has also been collected in southern Africa,

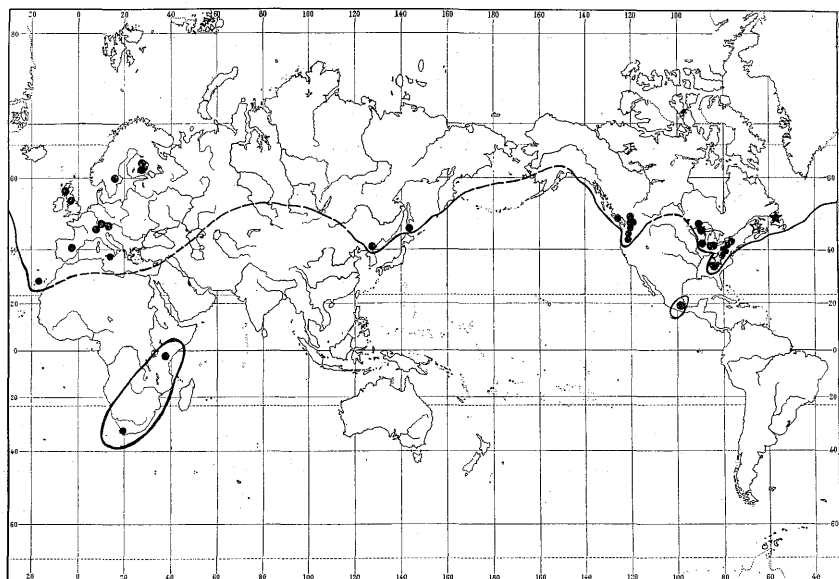


Fig. 2. Distribution map of *Lobaria pulmonaria* (L.) Hoffm. Dots=specimens of chemical race I examined by us chromatographically. Asterisks=reliable records of chemical race II.

Dodge referring these plants to *Lobaria africana* Dodge. However we consider that these are conspecific with the Northern Hemisphere populations as they are similar chemically and the morphological differences fall within the range of continuous variation exhibited by *Lobaria pulmonaria* in the Northern Hemisphere.

Chemical race II has only previously been reliably reported from Virginia and New Brunswick in eastern North America before (Culberson, 1969) but I. Y. has examined one collection from Newfoundland (200 m n.w. of Cormack Wildlife Office, on dead *Abies* in thicket along brook in Humber East District, 23 vi 1956, T. Ahti 8744, NICH (ex H)). The reports of norstictic acid alone plants from Europe appear to be a result of the techniques used being inadequate to detect stictic and constictic acids. As so few specimens of this race are known it is not clear whether it has any taxonomic significance, i. e. if it should be regarded as a variety or as a chemotype. Its status is in need of further investigation.

**Allied Species** Non-sorediate specimens which have formerly been treated under *Lobaria pulmonaria* are known from Asia and Australia but differ from it in various ways. These include, for example, *L. orientalis* (Asah.) Yoshim. and *L. meridionalis* Vain. which will be discussed in a paper revising the Asiatic species of this genus by the senior author, and these are not, therefore, discussed further here.

***Lobaria immixta*** Vain., Kgl. Dansk. Vidensk. Selsk. Skr. Naturv. math. afd. 8(6): 398 (1924). Holotype: Canary Isles—Teneriffe, Las Mercedes, 25 ii 1921, F. Børgesen, Plant. canariens. no. 606, Herb. E. Vainio no. 10672 (TUR, no. 007017) (Plate IIc). Isotype in US.

Chemistry: gyrophoric acid alone.

Distribution: Known only from the islands off the coast of north-west Africa.

***Lobaria oregana*** (Tuck.) Müll. Arg., Flora (Regensb.) 72: 364 (1889).

*Sticta oregana* Tuck., Bull. Torrey Bot. Club 5: 20 (1874). Holotype: U.S.A.—Oregon, E. Hale (FH).

Chemistry: usnic, stictic, norstictic and constictic acids.

Distribution: Confined to the North Pacific coast of North America. It appears to belong to the same geographical element in the North American lichen flora as *Alectoria oregana* Tuck. and *Cornicularia californica* (Tuck.)

Du Rietz.

### References

- Asahina, Y. 1968. Lichenologische Notizen § 209. A new lichen substance often accompanied with stictic acid. Journ. Jap. Bot. 43: 97-101. Bauhin, C. 1671. *pinax* Theatri Botanicii. Basel. Culberson, C. F. 1969. Chemical studies in the genus *Lobaria* and the occurrence of a new tripeptide, 4-O-methylgyrophoric acid. Bryologist 72: 19-27. Culberson, W. L. 1967. Analysis of chemical and morphological variation in the *Ramalina siliquosa* species complex. Brittonia 19: 333-352. Dillenius, J. J. 1741. Historia Muscorum. Oxford. Dodoens, R. 1583. Stirpium historiae pemptades sex sive libri xxx. Antwerp. Fuchs, L. 1542. De historia stirpium commentarii insignes. Basel. Hale, M. E. jr. 1967. The Biology of Lichens. London. Hawksworth, D. L. 1970. Chemical and Nomenclatural notes on *Alectoria* (Lichenes) II. Taxon 19: in press. — and Sowter, F. A. 1969. Leicestershire and Rutland Lichens, 1950-1969. Trans. Leicester Lit. Phil. Soc., 63: 50-61. Howe, R. H. jr. 1912. The lichens of the Linnean herbarium with remarks on Acharian material. Bull. Torrey bot. Club 39: 199-203. Linnaeus, C. 1737. Flora Lapponica. Amsterdam. —. 1745. Flora Suecica. Stockholm. —. 1753. Species Plantarum, 2 vols., Stockholm. Micheli, P. A. 1729. Nova Plantarum genera juxta Tournefortii methodum disposita. Florence. Schindler, H. 1936. Über das Vorkommen der Norstictinsäure in der Lungenflechte *Lobaria pulmonaria* (L.) Hoffm.. Ber. Deutsch. bot. Gesell. 54: 240-246. Vainio, E. 1886. Revisio lichenum in herbario Linnaei asservatorum. Meddn. Soc. Fauna Flora fenn. 14: 1-10.

### Explanation of Plates I-II.

- Plate I. Lectotype of *Lichen pulmonarius* L., Herb. C. Linnaeus, sheet no. 1273. 103 (lower specimen), LINN. Scale in mm.
- Plate II. (a) Authentic specimen of *Lichenoides pulmoneum reticulatum vulgare* Dillenius, OXF. (b) Holotype of *Lobaria africana* Dodge, FH. (c) Holotype of *Lobaria immixta* Vain., TUR. Scale in mm.

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カブトゴケ (*Lobaria pulmonaria* (L.) Hoffm.) は 16 世紀ごろからヨーロッパの

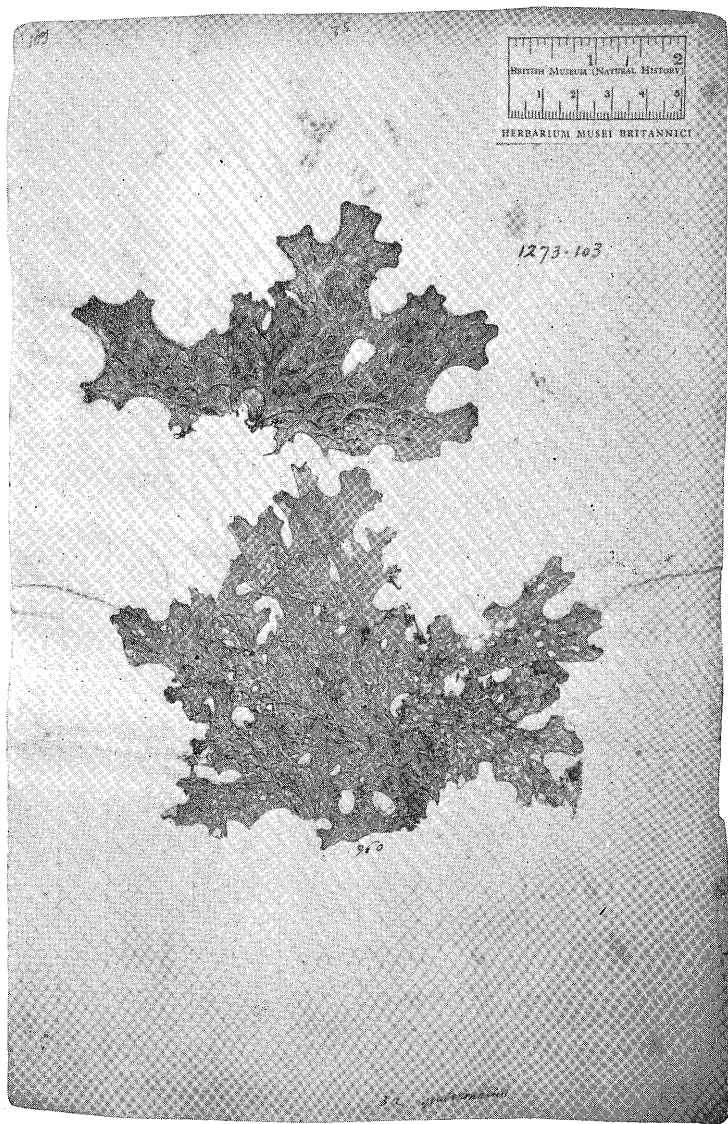


文献にあらわれるほど、古くからよく知られた地衣類である。今までに多くの変種や品種、近似種が記載され、成分上のちがいも報告されている。しかし、基準標本の選定がされていなかったもので、リンネ (C. Linnaeus) の標本庫に保存されているカプトゴケ標本 4 シートを調べシート番号 1273.103 の標本 (下) を選定基準標本にした。通常の顕微結晶法と TLC を併用して成分を調べた結果、タイプ品を含むリンネの標本からはすべて、スチクチン酸、ノルスチクチン酸、コンスチクチン酸を検出した。別に国立科学博物館、服部研、及びハウクスウォースの所持する標本 58 点について、成分を調べた結果、北米東部の 1 標本ではノルスチクチン酸のみしか検出できなかったが、他の 57 点の標本はすべてノルスチクチン酸の外にスチクチン酸、コンスチクチン酸の存在を証明することが出来た。カプトゴケの近似種はいずれも粉芽を持っていないので粉芽を持つ *Lobaria pulmonaria* (L.) Hoffm. とは区別できる。

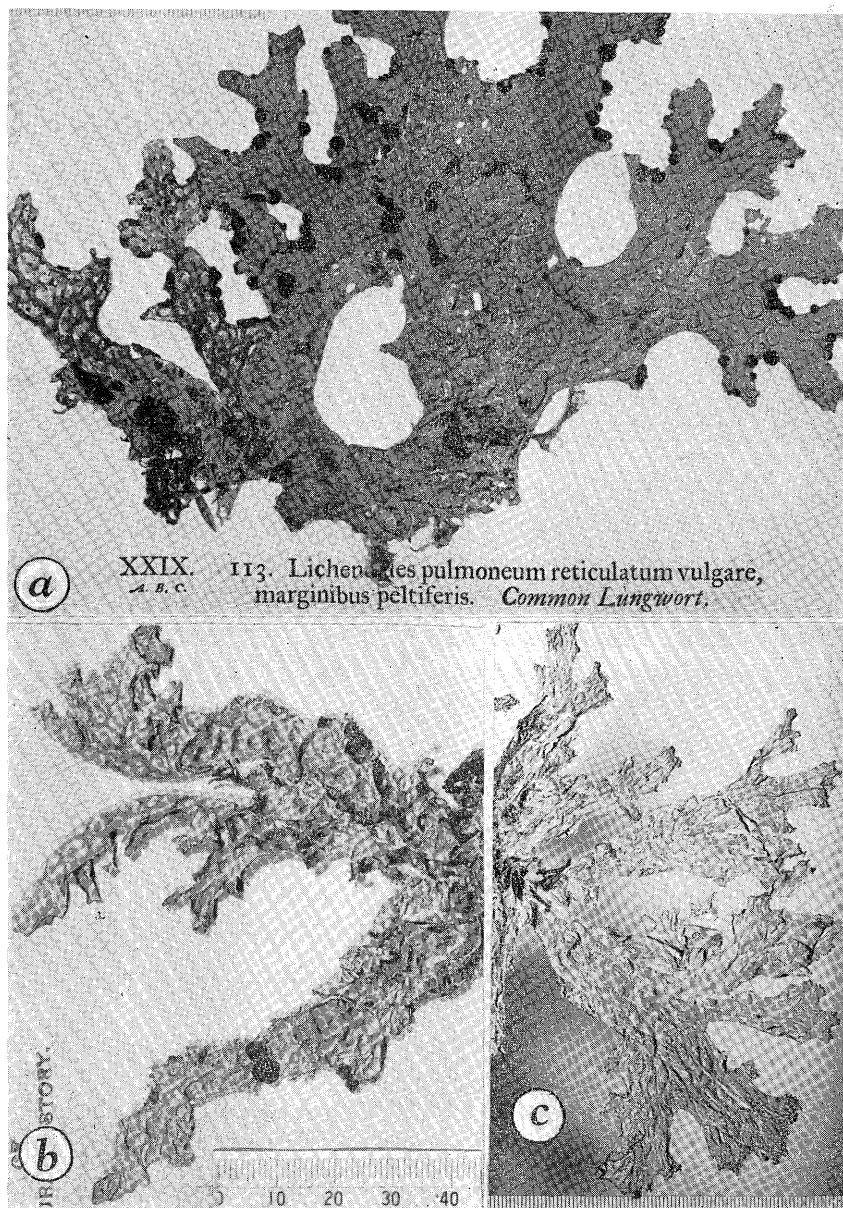
□Chicita F. Culberson: **Chemical and Botanical Guide to Lichen Products.** 628 pp. The Univ. of North Carolina Press, Chapel Hill, N. C., U. S. A.

\$ 12.50 著者は地衣学者 William L. Culberson の夫人で、夫君とともに数カ月の滞日生活を楽しんだことがある。朝比奈泰彦・柴田承二著の *Chemistry of Lichen Substances* (1954) が絶版になってから久しく、最新のデータによる同様な本の出版が望まれていた。本書は第 3 章 *Chemical Guide to Lichen Products* と、第 5 章 *Botanical Guide to Lichen Products* とを軸として構成されている。第 3 章では柴田承二博士が提唱した新しい分類方式によって、約 300 種の地衣成分を排列し、各物質について融点、その他の物理的性質、化学構造などを示し、さらに文献とともに地衣類における分布が示してある。朝比奈・柴田氏の本にあったような分離、構造決定、誘導体などについての説明はないが、その物質が地衣類以外の植物群から報告されている場合には、その分布も記されている。第 5 章では地衣類約 2000 種について種類ごとに、文献をあげながら化学成分が示されている。つまり、地衣類の種名と地衣成分のどちらからでも互に索引できるように工夫されている。これからの地衣類における *Chemotaxonomy* という見地からすれば、第 2 章の「地衣成分とその生合成および菌類代謝産物との関係」に述べられている著者の見解は大変参考になるであろう。本書に使用されている地衣類の学名は夫君の協力もあって最新のものである。全体にわたって夫妻協力のあとが見られ、本書はその見事な結晶と見るのはヒガ目であろうか。1965 年までの文献は殆んど完全に近いまで蒐集し、1967 年までの文献もかなり集められている。地衣成分に関する研究は日進月歩の状態なので、本書完成後著者は直ちに補遺の編集にとりかかっている。

(黒川 道)



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